

Claims

- [c1] 1. An apparatus for removing a part from a forming tool and supporting the part to maintain a formed shape, the apparatus comprising:
a support member having a surface contoured to conform to a formed shape of the part and an aperture disposed in the surface for directing a pressurized gas toward the part to cool the part and cause the part to be released from the forming tool without being contacted by the support member; and
a manipulator for moving the support member a predetermined distance from the part while the part contacts the forming tool;
wherein the surface supports the formed shape of the part when the part is removed from the forming tool to inhibit distortion as the part cools.
- [c2] 2. The apparatus of claim 1 wherein the surface is a metal sheet formed in the forming tool to provide the surface contoured to conform to the formed shape of the part.
- [c3] 3. The apparatus of claim 1 wherein the surface is an open cell metal foam.

- [c4] 4. The apparatus of claim 1 further comprising a sensor disposed adjacent to the surface for detecting the presence of the part after the part is released from the forming tool.
- [c5] 5. The apparatus of claim 1 further comprising a manifold disposed adjacent to the surface, the manifold in fluid communication with the aperture and a source of pressurized gas.
- [c6] 6. The apparatus of claim 1 wherein the manipulator is a robot.
- [c7] 7. The apparatus of claim 1 wherein the pressurized gas is provided at a first velocity to release the part and a second velocity to cool the part after release from the forming tool.
- [c8] 8. The apparatus of claim 1 wherein the pressurized gas is provided at a first flow rate to release the part and a second flow rate to cool the part after release from the forming tool.
- [c9] 9. An apparatus for releasing a part from a superplastic forming die without physical contact between the apparatus and the part, the apparatus comprising:
a part removal assembly having a contoured part receiv-

ing support and a manifold, the contoured part receiving support having a plurality of apertures and the manifold located adjacent to the contoured part receiving support and providing cooling air to the contoured part receiving support;

a manipulator for positioning the part removal assembly;
and

a sensor for detecting the release of the part from the superplastic forming die;

wherein cooling air is directed by the plurality of apertures toward the part to cool the part until it is released from the superplastic forming die.

[c10] 10. The apparatus of claim 9 wherein the apparatus provides cooling air after the part is released from the superplastic forming die to cool the part and inhibit warpage.

[c11] 11. The apparatus of claim 9 wherein the cooling air is provided at a substantially uniform velocity through each aperture.

[c12] 12. The apparatus of claim 9 wherein the cooling air is provided at a substantially uniform flow rate through each aperture.

[c13] 13. The apparatus of claim 9 wherein the plurality of

apertures have the same shape.

[c14] 14. The apparatus of claim 9 wherein the plurality of apertures are disposed parallel to each other.

[c15] 15. A method for removing a part from a forming tool and supporting the part to maintain a formed shape with an apparatus, the method comprising:
positioning the apparatus a predetermined distance from the part;
directing a cooling gas toward the part at a first velocity with the apparatus to cause the part to be released from the forming tool;
detecting the release of the part from the forming tool;
providing the cooling gas at a second velocity to facilitate uniform cooling of the part;
moving the apparatus and part away from the forming tool; and
removing the part from the apparatus when the part is cooled to a temperature at which the part independently maintains the formed shape.

[c16] 16. The method of claim 15 wherein the predetermined distance is in a range of 6 mm to 50 mm.

[c17] 17. The method of claim 15 wherein the first velocity is not equal to the second velocity.

[c18] 18. The method of claim 15 wherein the cooling gas is provided at a first flow rate to cause the release of the part from the forming tool and a second flow rate after the part is released from the forming tool to promote uniform cooling of the part.

[c19] 19. The method of claim 18 wherein the first flow rate is less than the second flow rate.

[c20] 20. The method of claim 15 wherein a first time period required to position the apparatus, provide a cooling gas at a first velocity, and detect the release of the part is less than a second time period required to cool the part to a temperature at which the part independently maintains the formed shape.